

Biodiesel and Renewable Diesel Workgroup

California Biodiesel Multimedia Evaluation Tier I Report

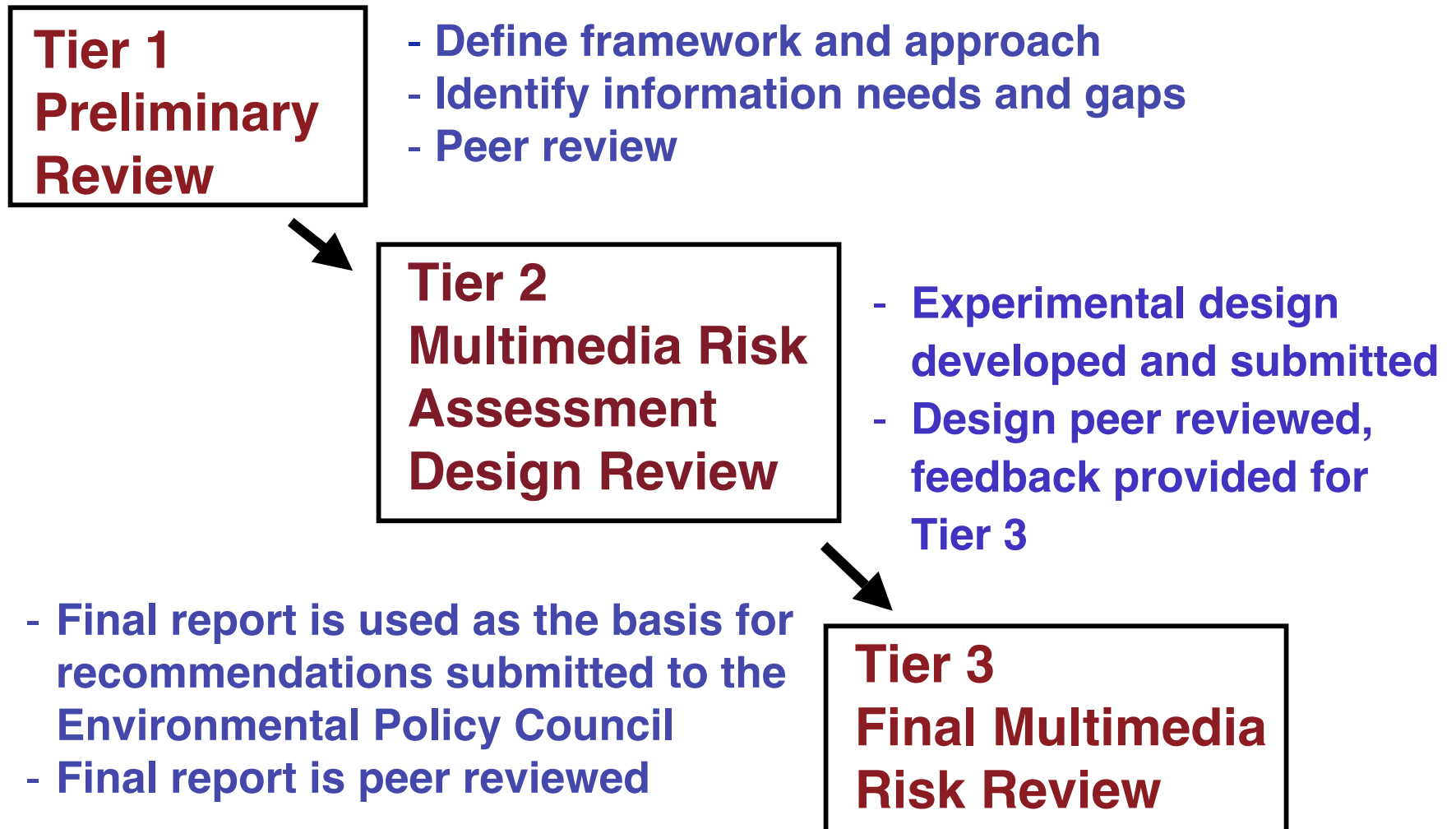
**March 12, 2009
Sacramento, CA**

Tom McKone, University of California, Berkeley

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Tiered Approach Refresher



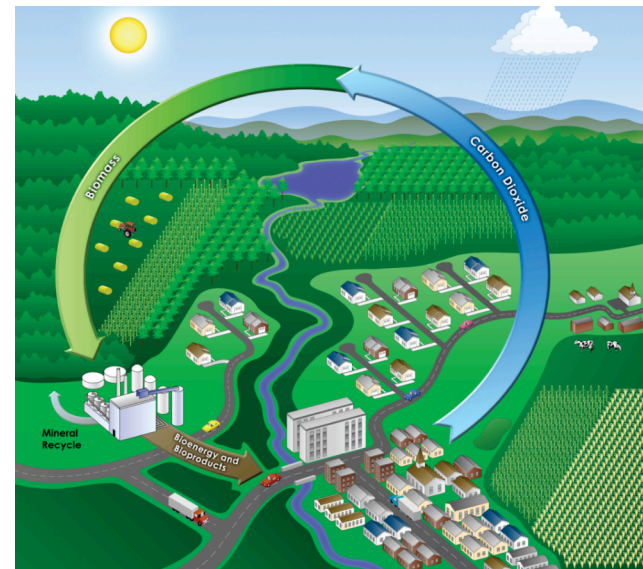
Overview of the Biodiesel Tier I Report

- **Biodiesel Background Information**
- **Biodiesel Life Cycle**
 - Biodiesel Feedstock Collection/Production
 - Production of Biodiesel
 - Storage and Distribution of Biodiesel
 - Use of Biodiesel
- **Release Scenarios**
- **Environmental Transport and Fate of Biodiesel**
- **Biodiesel Toxicity**
- **Biodiesel Life Cycle Impacts**
- **Conclusions about Key Information Gaps**



Biodiesel Background

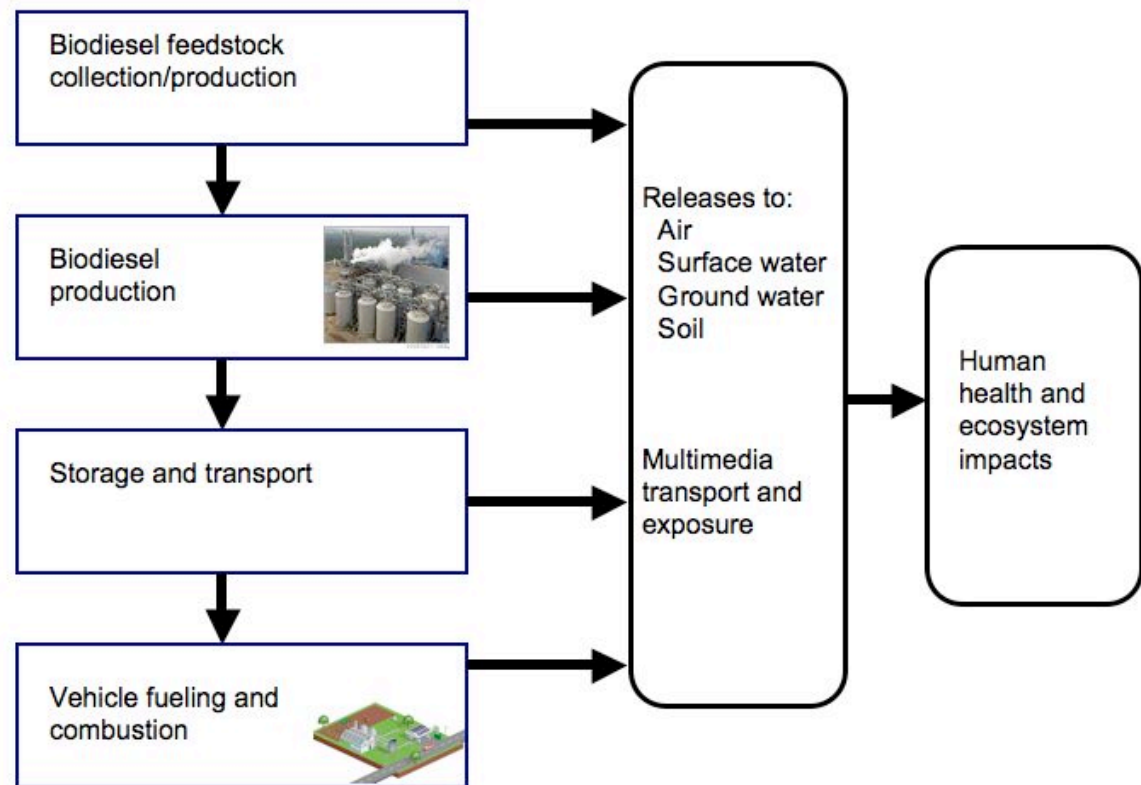
- **Biodiesel is composed of mono-alkyl esters of long chain fatty acids derived from:**
 - a broad range of vegetable/seed oils
 - recycled cooking greases or oils
 - animal fats
 - algal oils
- **Biodiesel can be used as a pure fuel or as a blend with petroleum diesel**
- **Our focus is on a blend of 20% biodiesel with 80% standard ULSD (B20) and on 100% biodiesel (B100), partial evaluation of B5**
- **A key goal of encouraging fuels such as biodiesel is to reduce California's carbon "footprint"**



Courtesy of C. Somerville, UC Berkeley

Biodiesel Life Cycle

- Biodiesel Feedstock Collection/Production
- Production of Biodiesel
- Storage and Distribution
- Use of Biodiesel



Biodiesel Feedstock Collection/Production

- Primary biodiesel feedstocks expected to be used in California include:

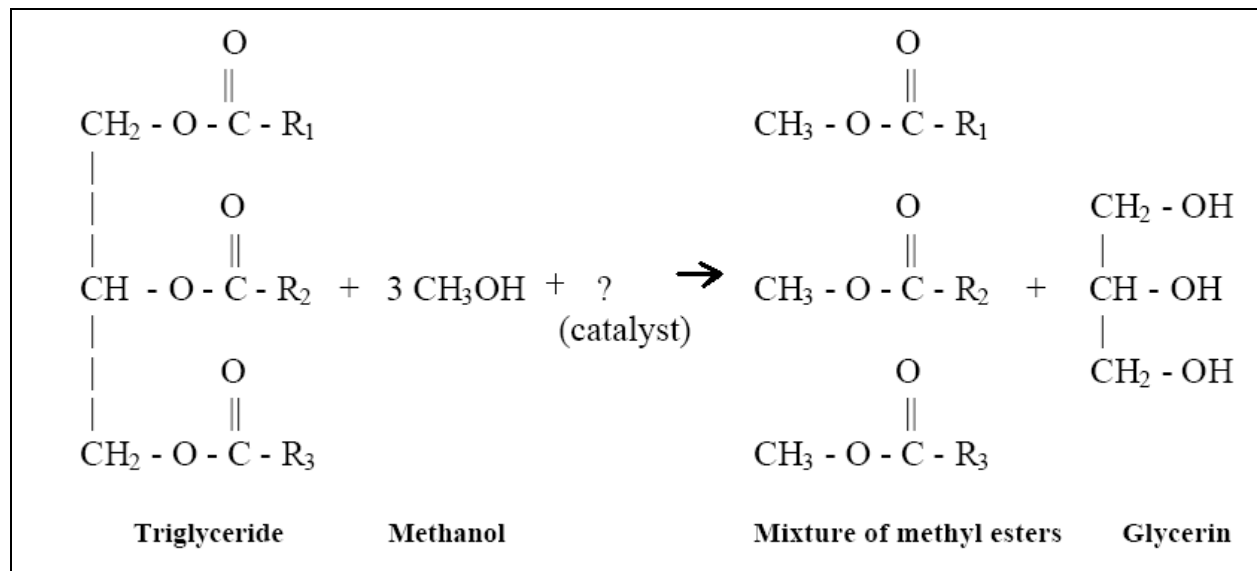
- soybean oil
- animal tallow
- yellow grease
- canola
- safflower
- palm oil
- algae
- trap (brown) grease



- Biodiesel feedstocks are classified by their fatty acid profile
- Price, availability, origin, geography, and consistent quality generally dictate which feedstock biodiesel producers use

Production of Biodiesel

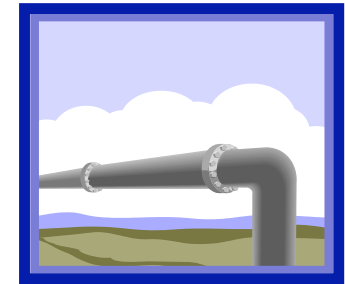
- To make biodiesel, a vegetable oil or fat is subjected to a chemical reaction known as transesterification



- Air emissions and hazardous wastes are important considerations for production operations

Storage and Distribution

- Material compatibility is important to consider during the storage and distribution of biodiesel
- Biodiesel is susceptible to chemical changes during long-term storage
- Chemical additives to address
 - oxidative stability
 - microbial contamination
 - increased water affinity
 - cold-flow properties
 - increased NOx emissions of biodiesel
- Routine emissions and “off-normal” events (pipe-breaks, large spills) must be addressed



Use of Biodiesel

- In the fuel-use stage, the releases of greatest concern are emissions to air
- But there are also potential releases to water and soil
- Several studies have determined biodiesel blends exhibit reductions in hydrocarbons (HC), particulate matter (PM) and carbon monoxide (CO) emissions
- There are also vehicle operability issues with biodiesel blends:
 - cold fuel flow
 - fuel foaming
 - water separation
 - fuel oxidative stability

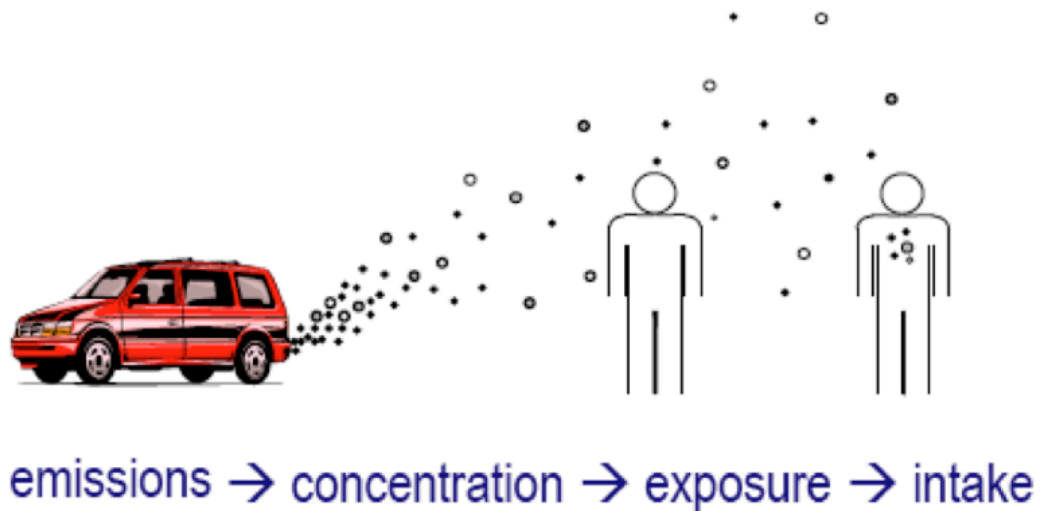


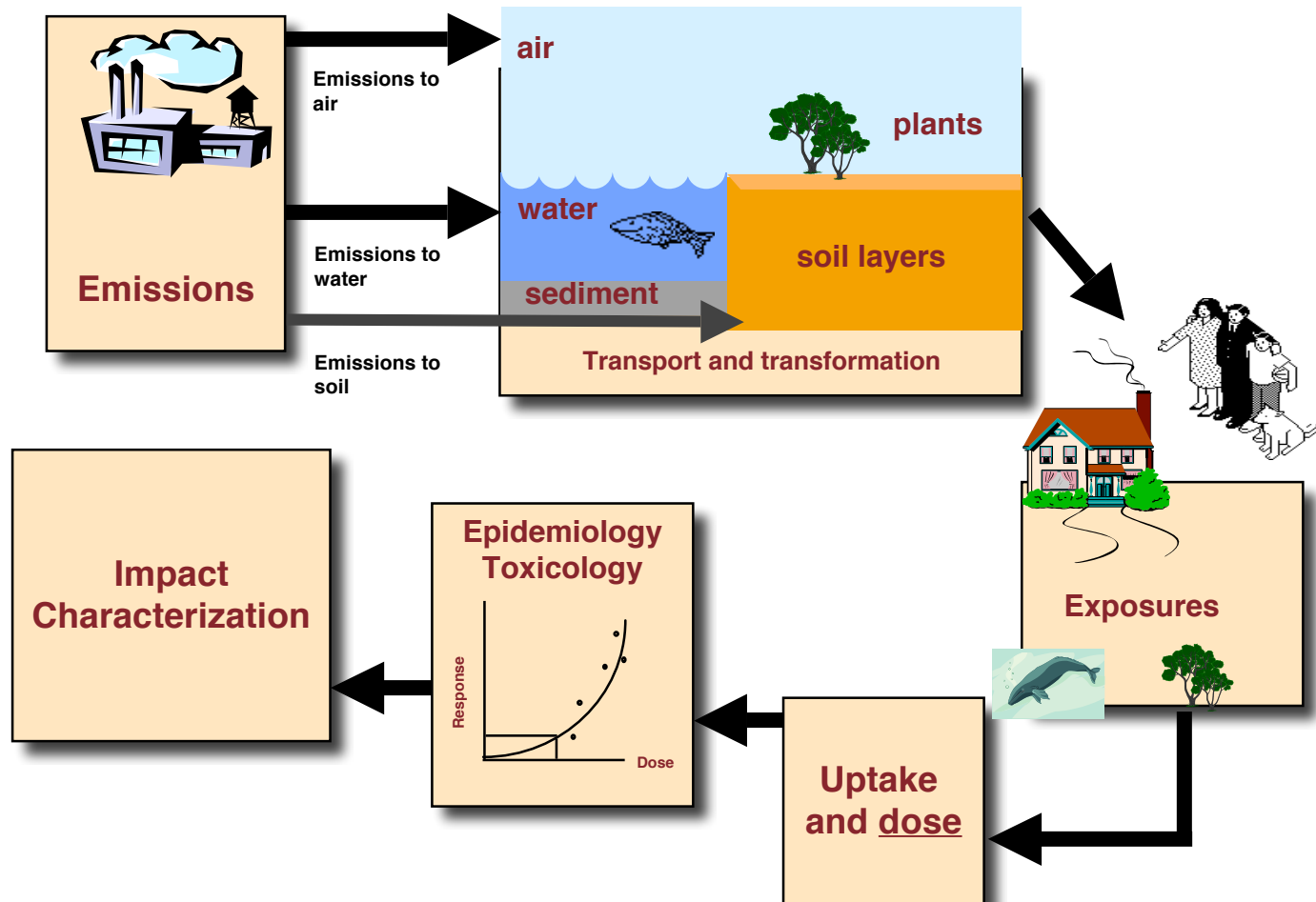
Figure from Julian Marshall University of Minnesota

Defining Release Scenarios

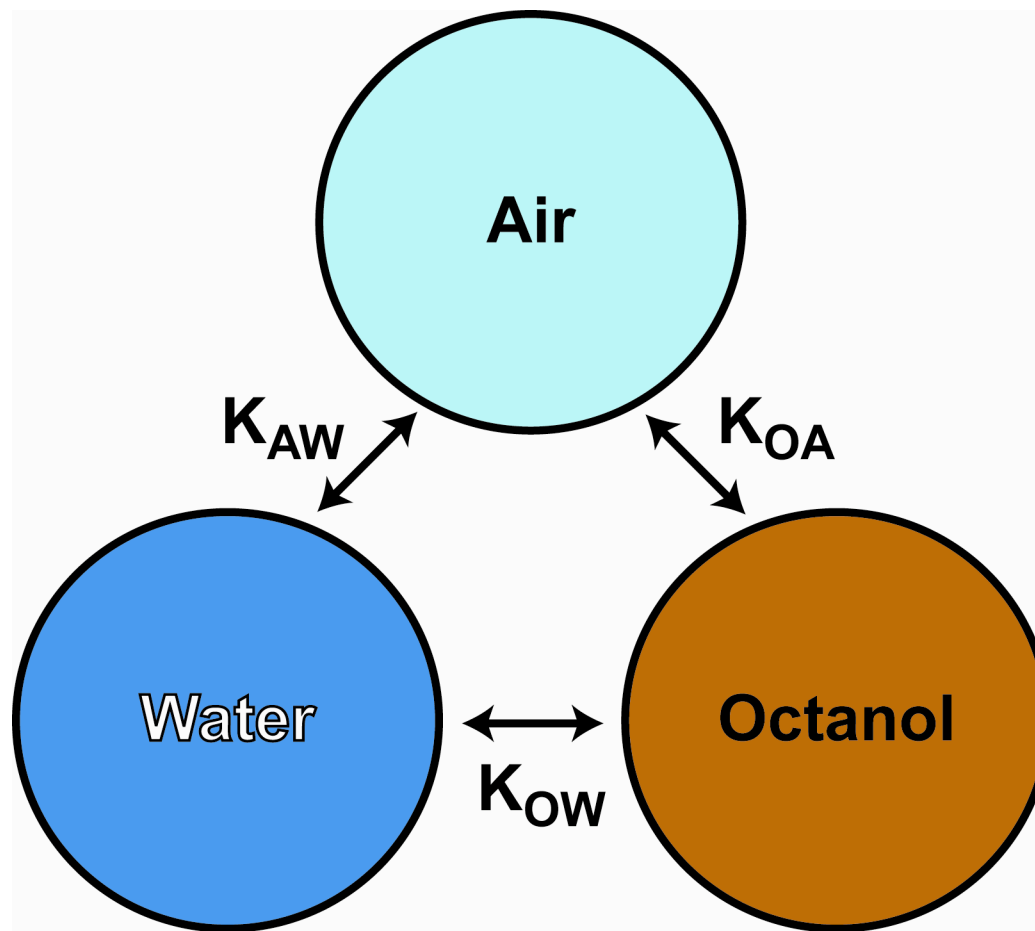
- Selection of biodiesel feedstock
- Selection of additives mix
- Identify normal (routine) releases during production for example
 - Hexane or CO₂ released to the air during seed extraction.
 - Odors associated with waste biomass
 - Methanol releases to air or water
 - Used process water discharges of various pH and trace-chemical composition
- Normal releases during use include tailpipe emissions, both to air and to surface waters (marine vehicles)
- Identify off-normal releases, such as leak or rupture of:
 - an above-or below-ground storage tank and associated piping,
 - rail tank car, tanker truck, or tanker ship.
 - bulk fuel transport pipeline



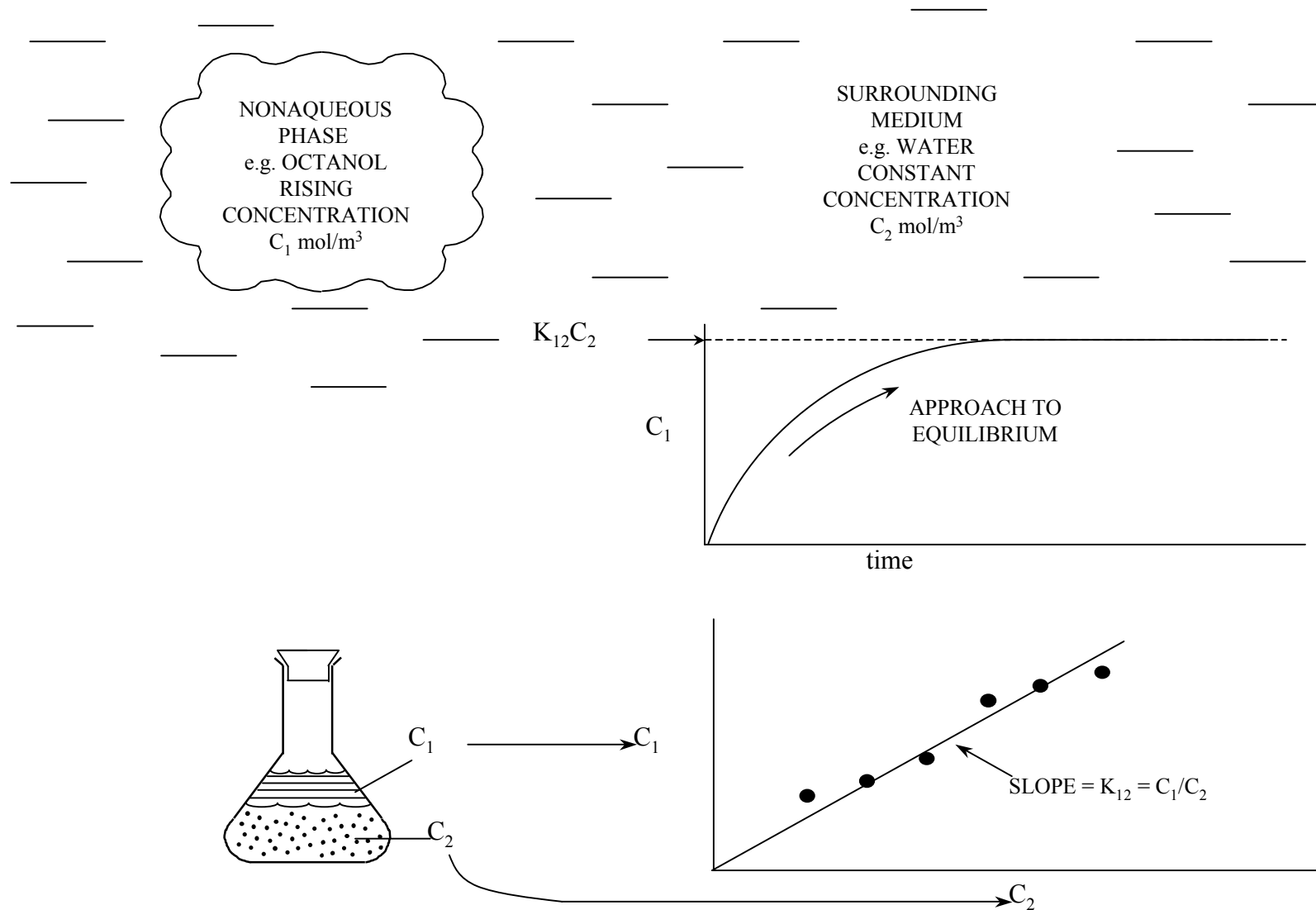
Environmental Transport and Fate



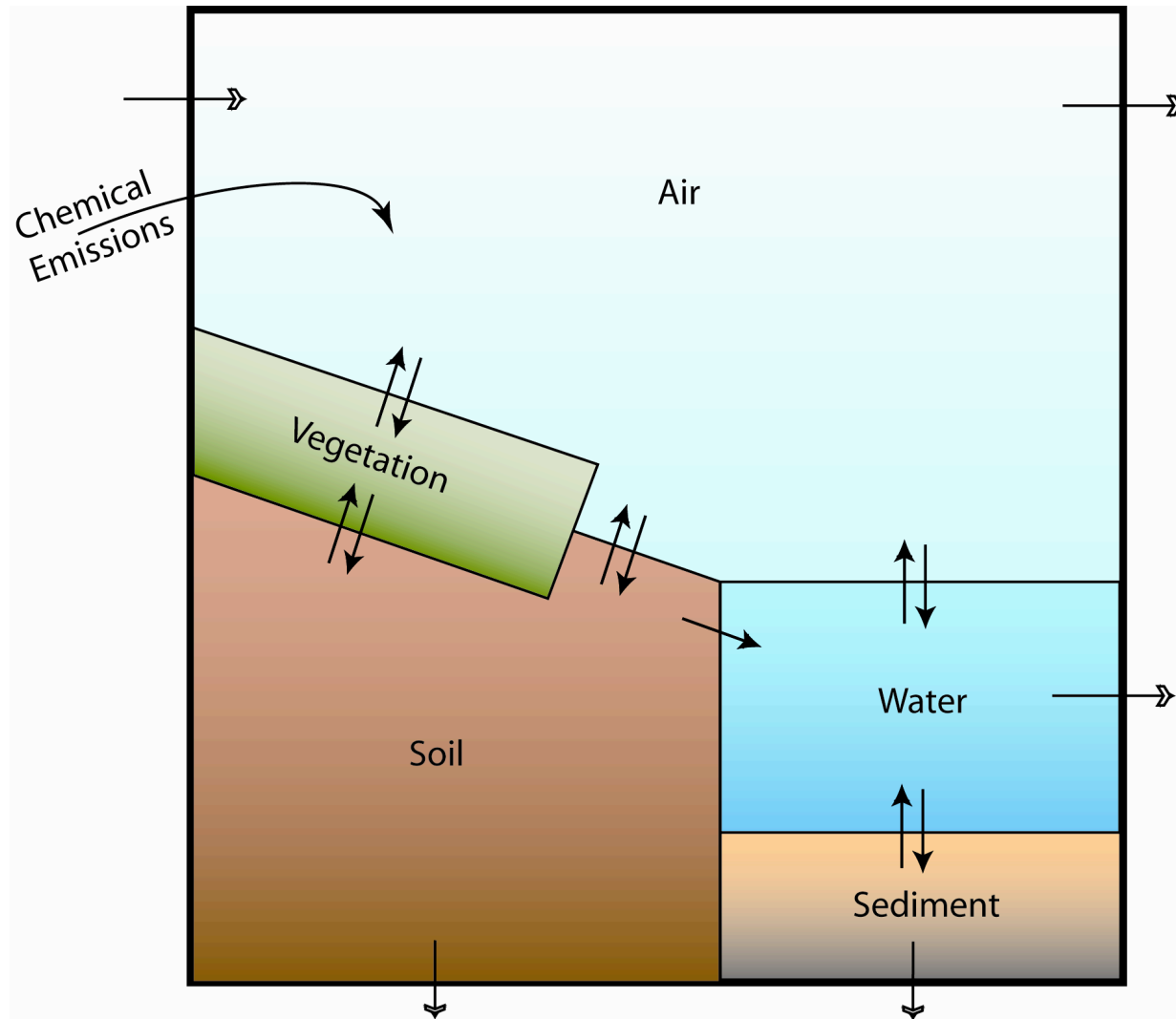
The long-term behavior chemicals in the environment is determined by their partitioning between three primary media:



Experimental Determination of Partition Coefficients



Level III multimedia contaminant fate model



Biodiesel Toxicity

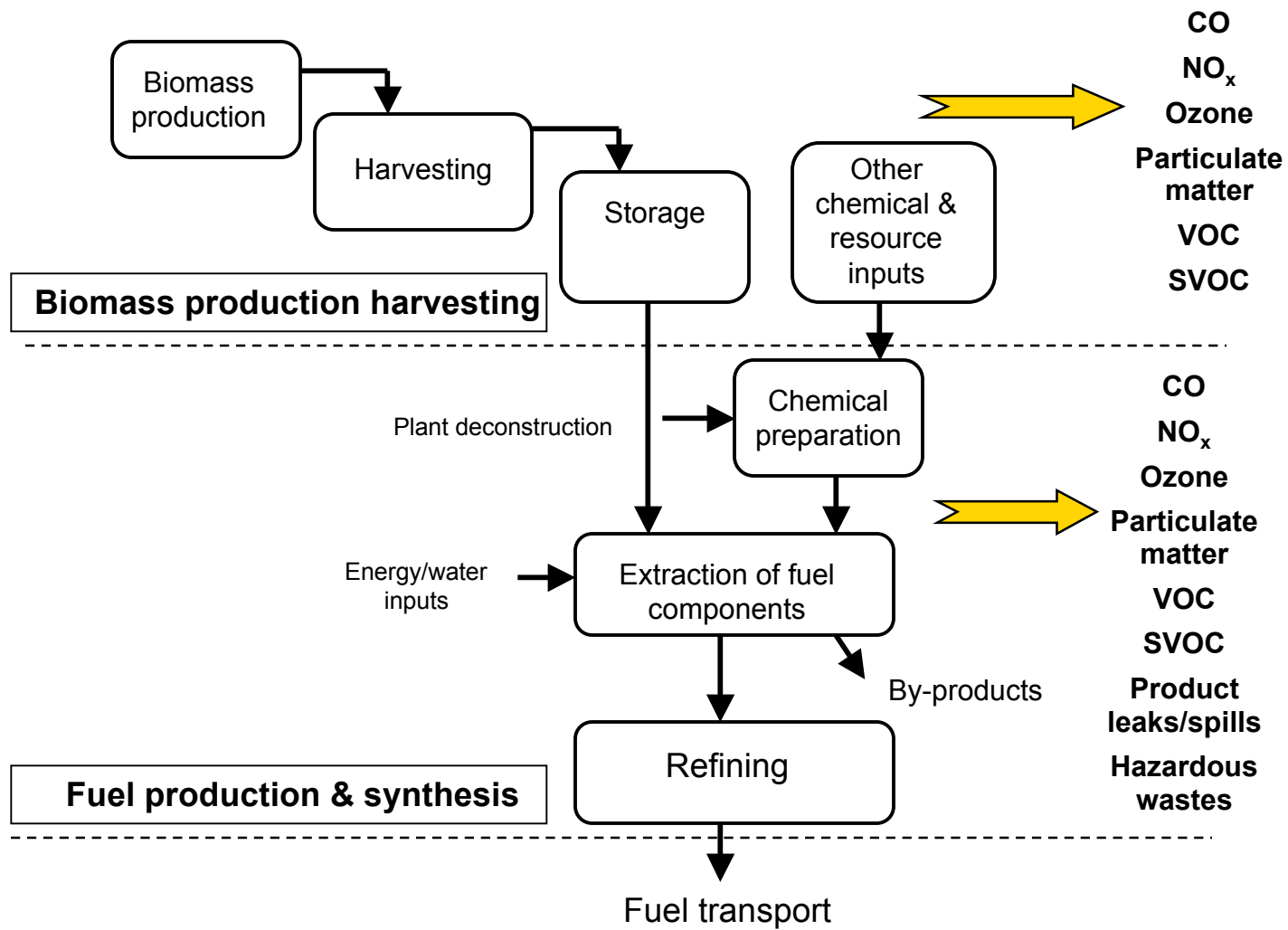
- **Human and ecological risk**
 - Hazard identification
 - Toxicity (dose-response)
 - Potential for exposure
 - Sensitive populations
- **Toxic air pollutants**
- **Toxicity assessment to fill data gaps**

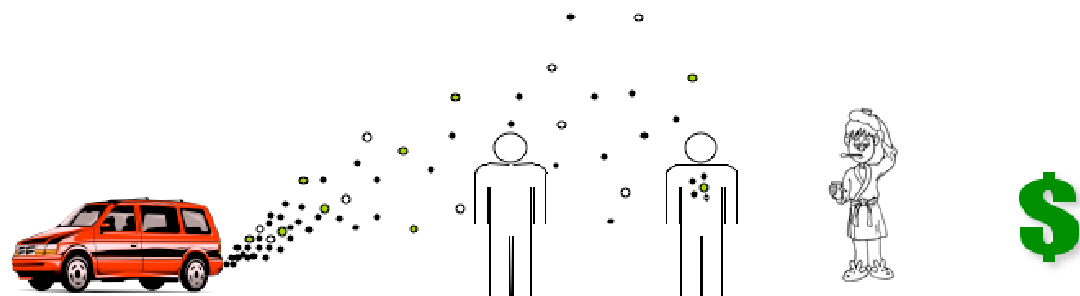
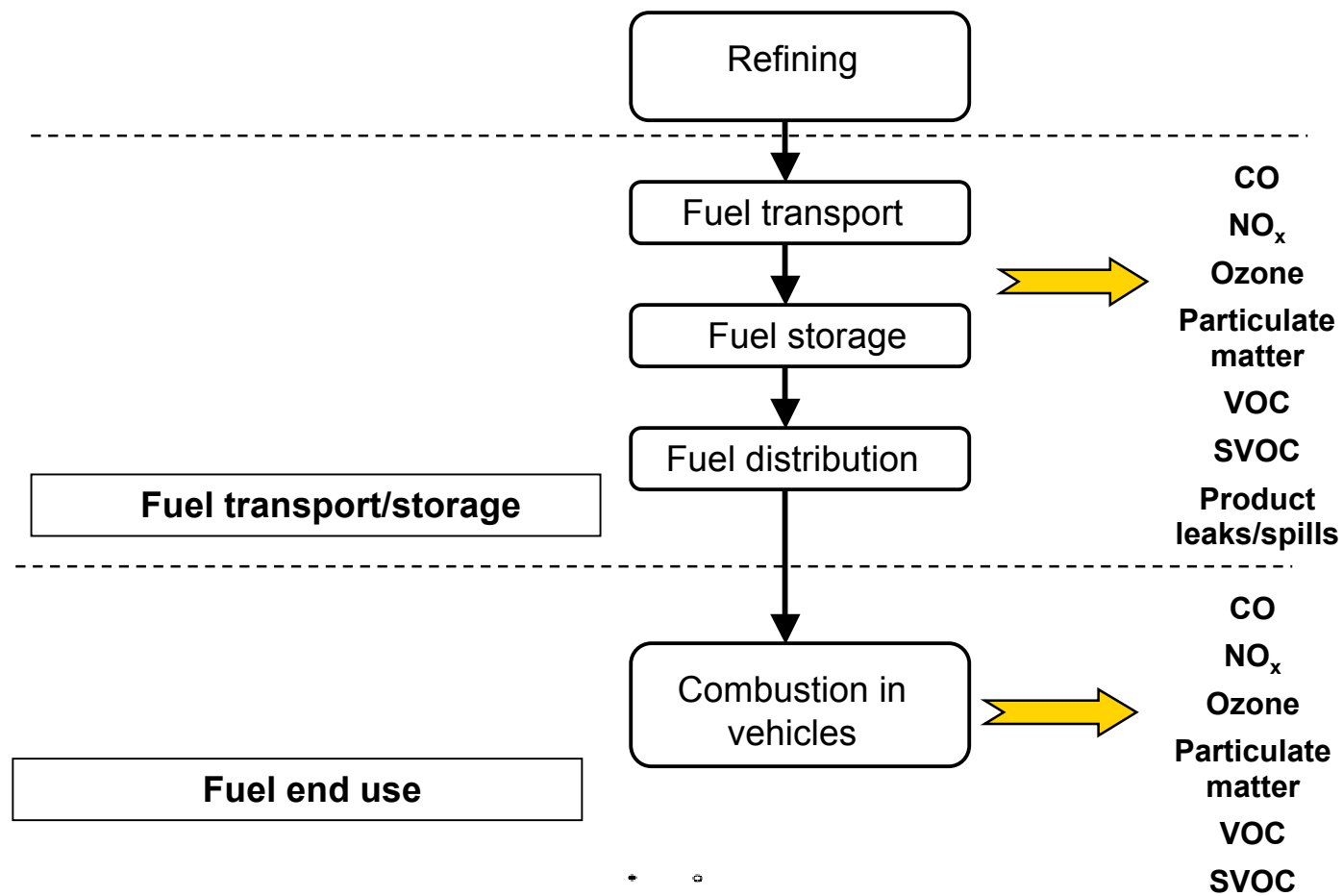


Biodiesel Life-Cycle Impacts

- **Life-Cycle Approach**
 - Biomass production and harvesting or feedstock collection
 - Fuel production
 - Fuel transport and distribution
 - Fuel combustion
- Pollutant releases at each life stage
- Transport and fate
- Exposure and dose
- Toxicology and risk







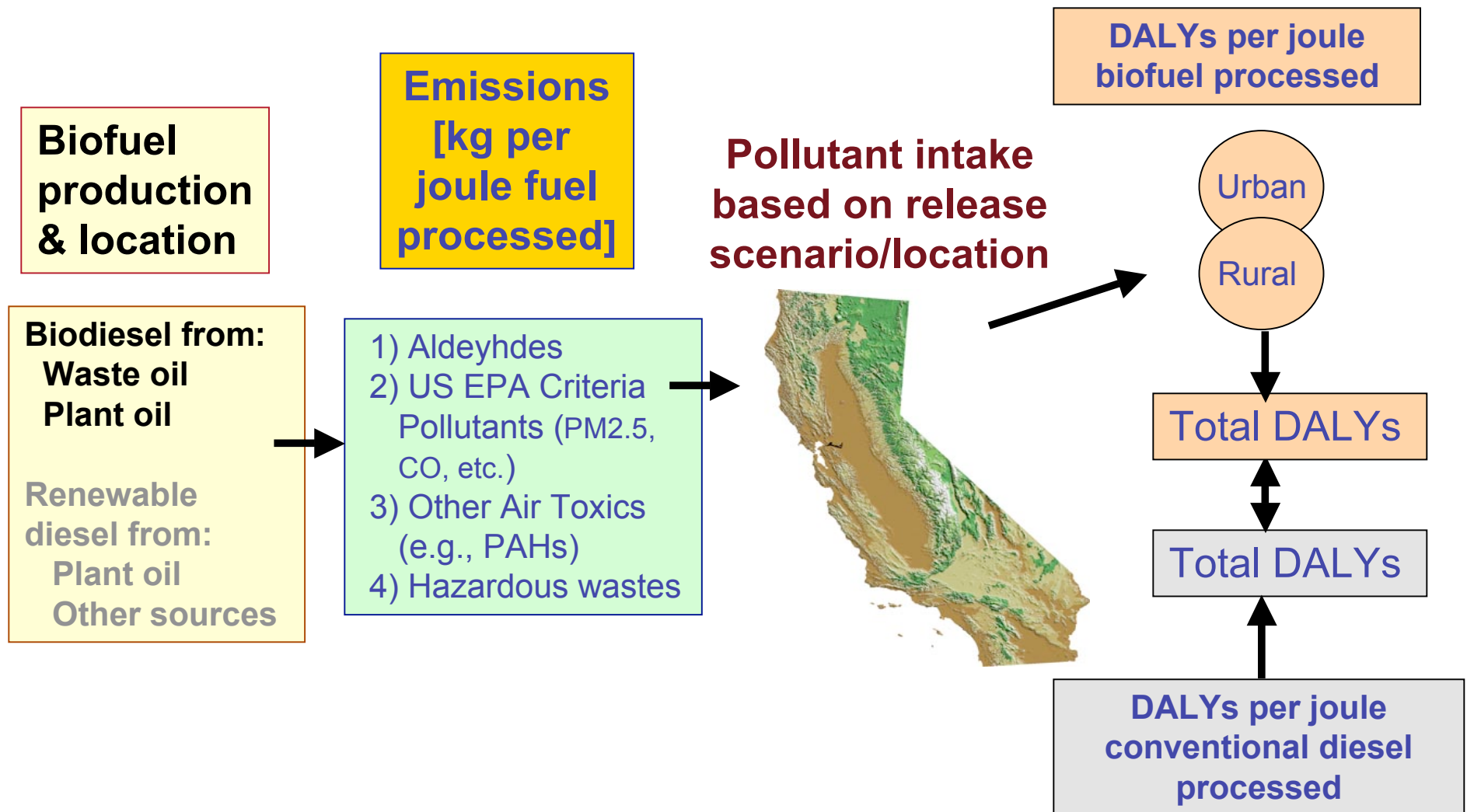
emissions → concentration → exposure → health effects → damage

Graphic courtesy of
Julian Marshall
University of Minnesota

Life Cycle Impact

Disability adjusted life years (DALYs)

Potential disease burden



Conclusions About Key Information Gaps

- **Additives composition, use, and impact**
 - How biocides and anti-oxidants impact biodegradation
 - How priority additive impact human and ecosystem health
 - How cold flow property controllers impact multiphase transport
 - *toxicity*
- **Subsurface fate and transport properties**
- **Releases - Material Compatibility**
- **Biodegradation of all biodiesel components in soils and aquifers**
- **More information on air emissions**
- **Missing toxicological data**